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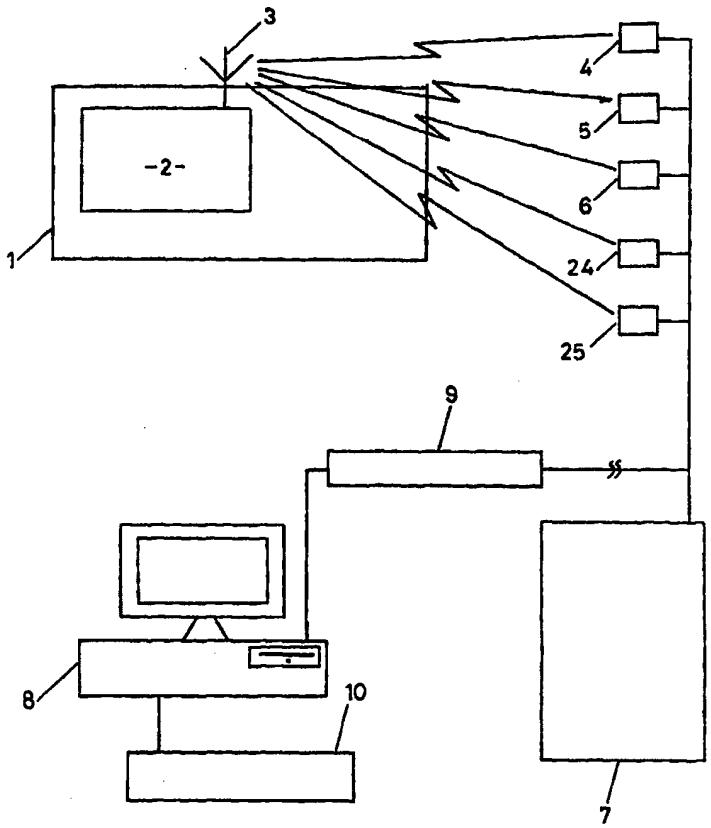
(54) Title: INTERACTIVE CONTROL OF REMOTE EQUIPMENT

(57) Abstract

A device (1) for tracking portable items of equipment, for example packages or motor vehicles. The device (1) monitors the status of various functions within the equipment or vehicle via sensors (16) such as determining if the ignition has been turned on. The device transmits this information to a remotely located monitoring computer (8) over the digital cellular telephone network. The device also records information relating to the direction and distances travelled and is able to continually determine the current position of the equipment or vehicle by occasionally calculating the position using signal strength and identification information transmitted by each receivable cellular transmitter (4, 5, 6, 24, 25) and complimenting this static information with continuous change in position information from distance and direction sensors (23). The remote monitoring computer (8) may monitor the position of and issue control signals to the device in the event that the equipment or vehicle is stolen. The control signals are received by the device which may then control selected systems within the equipment or vehicle to render it unusable. Further uses of the device are also disclosed including remote automated medical monitoring and medication dispensing.



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"INTERACTIVE CONTROL OF REMOTE EQUIPMENT"

Technical Field

This invention relates to tracking, locating and controlling systems for equipment and more particularly though not solely to portable equipment or vehicle tracking systems utilising the digital cellular telephone network to allow remote, interactive control and monitoring of the vehicle being tracked.

Background Art

Vehicle tracking systems which utilise the cellular telephone network are well known. An example is disclosed in US Patent No. 5,218,367 in which a vehicle is provided with a cellular processing unit connected to a plurality of alarm sensors (including break-in sensors) and a cellular antennae which transmits signals to a remote alarm monitoring station housing a computer. The cellular processing unit determines the position of the vehicle utilising the cell identifying information and signal strength information received from all adjacent receivable (that is within range), fixed cellular telephone sites when an alarm sequence is initiated by any one of the alarm sensors. In the event of an alarm being raised, a packet of information is transmitted by the cellular processing unit to the computer at the remote alarm monitoring station which identifies the type of alarm raised and vehicle identifying information as well as adjacent cell and relative signal strength information so that the computer at the alarm monitoring station may calculate the actual location of the vehicle.

The tracking system previously described has the disadvantage that it utilises a one way communication system such that information from the monitored vehicle is available at the monitoring station, however, the monitoring station has no control over the monitored vehicle. In the event of an alarm being raised in the monitored vehicle, there is no possibility of remotely controlling components within the vehicle in an attempt to discourage intruders or to disable the vehicle. Also the system disclosed is unable to determine the vehicle's position accurately as it relies solely on signal strength information which is heavily influenced by the surroundings (for example buildings causing fading and multi-path interference). If the monitored vehicle were to travel into the countryside

where the density of cellular telephone sites is very low, the accuracy with which the vehicle's position may be monitored is further reduced.

Disclosure of the Invention

It is, therefore, an object of the present invention to provide interactive equipment monitoring apparatus which goes some way towards overcoming the above disadvantages or which will at least provide the public with a useful choice.

Accordingly, in one aspect, the invention may broadly be said to consist in interactive equipment monitoring apparatus wherein said equipment is located within a cellular communication network having fixed cellular network transmitters which, depending on their spatial relationship with said equipment are either able to be received (receivable) or not receivable comprising:

first transceiving antenna means located on said equipment,

first control means which receives signals from said fixed receivable cellular network transmitters via said first transceiving antenna means, said signals including signal strength and unique identification information for all said receivable cellular network transmitters, said first control means also being provided with inputs from sensors monitoring the status of selected functions of said equipment and having outputs to control selected equipment systems and an output to said first transceiving means to allow transmission of information received from said sensors monitoring said selected equipment systems and status information of said functions, said first control means being able to alter the status of said equipment systems,

second transceiving means remotely located from said equipment which transmits and receives information to and from said first transceiving means, and

second control means, remotely located from said equipment, connected to said second transceiving means which receives said information from said first control means and which also transmits control signals to said first control means in response to said information received to control the status of said selected equipment systems to allow remote control and monitoring of said selected equipment systems.

In a second aspect, the invention may broadly be said to consist in a method of tracking the location and movement of equipment located within a cellular communication

network having fixed cellular network transmitters which, depending on their spatial relationship with said equipment are either able to be received (receivable) or not receivable wherein said equipment is provided with sensing means to constantly determine information relating to the movement and orientation of said equipment from distance measuring means, turn angle measuring means and compass means and said equipment is also provided with static position determining means to determine information relating to the approximate position of said equipment, said method comprising the steps of:

i) receiving and storing information from said sensing means in a first in first out memory substantially continuously such that the most recently received information replaces earlier received information,

ii) occasionally receiving information from said static position determining means,

iii) combining said information received from said static position determining means with said stored information from said sensing means to substantially continuously determine the position of said equipment.

Brief Description of the Drawings

The invention consists in the foregoing and also envisages constructions of which the following gives examples.

One preferred form of the present invention will now be described with reference to the accompanying drawings in which;

Figure 1 is a diagrammatic diagram of the interactive vehicle monitoring apparatus of the present invention; and

Figure 2 is a diagrammatic block diagram of the Secure-Net Unit (SNU) block shown in Figure 1.

Best Mode for carrying out the Invention

With reference to Figure 1, interactive equipment monitoring apparatus is shown in which the movements and activity of equipment, for example vehicle 1 (or other easily transportable item, piece of equipment such as a package or person) is determined and monitored. The vehicle 1 is provided with a first control means 2 (referred to in this specification as the Secure-Net Unit (SNU)) which is connected to enable the reception

and transmission of information via a first transceiving antenna means or aerial 3. The Secure-Net Unit 2 utilises the cellular telephone network to transmit and receive information and preferably, though not solely, the present invention utilises the GSM (Global System Mobile) digital cellular network because of the inherent advantages of digital communication systems including their inherent speed advantage over the analogue cellular networks. Five cellular sites are shown (4, 5, 6, 24 and 25) which are in range of the Secure-Net Unit 2 in vehicle 1 although it is obvious that there are a great many more cellular sites available to the Secure-Net Unit which are not shown in Figure 1.

Each of the cellular sites 4, 5, 6, 24 and 25 are connected to a cellular network control computer 7. When the Secure-Net Unit 2 communicates via the cellular telephone network, the network control computer 7 is provided with information including the actual cellular site being accessed by the Secure-Net Unit along with the unique code number pre-programmed into each Secure-Net Unit so that the individual vehicle being monitored may be identified.

A second control means 8 which may comprise a computer and which will be referred to in this specification as the secure-net monitoring computer system, is remotely located from the vehicle 1 and the cellular network control computer 7 and is connected to the cellular network by channel 9 which may, for example, represent a standard phone line modem connection, a cellular modem connection or a VHF radio or microwave link. The secure-net monitoring computer system 8 is further connected to an output device 10 which may for example comprise data output to the police computer system, a phone contact to the owner of vehicle 1 or phone contact to a private security company.

With reference to Figure 2 the Secure-Net Unit 2 within vehicle 1 is shown in more detail. It can be seen in Figure 2 that the Secure-Net Unit 2 comprises a number of interconnected sub systems. The first module is the Cellular Communication Module (CCM) 11 which has been developed to provide a data capture and processing facility and also provides the communication interface with the GSM cellular telephone network. The cellular communication module 11 includes a transmitter and a receiver which preferably operate over a bandwidth of between 800 - 900 MHz. The cellular communication module is provided with all the necessary hardware and software requirements to comply with the network operating standards and interfaces with the standard GSM GiSMo 22 (often

referred to as a "smart card" as supplied by the cellular network provider and which is usually inserted into a cellular telephone).

A further module is the position location discriminator module 12 which captures the system management information transmitted by the GSM cellular network to obtain data relating to the position of the vehicle. As the cellular communication module 11 receives incoming signal information it determines the signal strengths of all receivable cellular sites with signal strengths above a predetermined level and feeds them to the position location discriminator 12 in highest ranking order. A Vehicle Movement and Direction Sensing Module (VMDSM) 23 which is an integrated series of measuring devices including a trip counter, inclinometer or turn sensor and electronic compass also provides position location discriminator 12 with information relevant to the position and movement of the vehicle. The VMDSM provides the position location discriminator 12 with the three separate data sources relating to the position of vehicle 1 depending on whether 1) the vehicle is at rest; or

2) the vehicle is moving.

1) When the vehicle is in a state of rest, the approximate position is calculated from the signal strengths of all receivable cellular transmitters by the position location discriminator 12. Added to this data is extra information in the form of the last three memorised compass bearings as well as the direction and angle of the vehicle turns in 45° increments. This information is added to the signal data transmitted to the monitoring station tracking computer.

2) When the vehicle is moving, information from the three sensors is fed continuously into a first in/first out memory unit within the VMDSM 23. This information is derived from the:

   a) trip counter, giving distance travelled from a known reference point, already determined by data from the position location discriminator 12,

   b) turn sensor, providing the direction and the degree of any turn in 45° increments as well as the front to back angle of inclination of the vehicle,

   c) compass, providing a compass heading from magnetic North.

An advantage of the turn indicator and compass is that the amount of data required to be stored and transmitted is reduced. The combination of this data along with the signal

strength information improves the on-line tracking ability of the SNU at all times, especially in areas of poor signal quality, signal dropout, signal multi-path and limited coverage of cellular transmitters. The position location discriminator 12 stores the signal strength information, cell site identification and other direction or movement information for later re-transmission by the cellular communication module 11 to the secure-net monitoring computer system 8.

Optionally connected to the position location discriminator 12 is a data input/output module 13 which allows communication between an external input/output device 14 such as a computer or fax machine (and may also include voice and video equipment). The data input/output module 13 provides an RS232 data interface and controls conversion between serial or parallel format as required.

A security system monitoring module 15 which monitors the outputs of a plurality of security sensing devices 16 connected to any one of its inputs. For example, the security system monitoring module may be controlled to scan the outputs of up to 30 separate input devices 16 once every fifth of a second. Each of the security sensing devices monitors a specific function of the vehicle, for example, the status of the headlights, whether or not the ignition is turned on, the level of charge in the battery etc. The security system monitoring module 15 may also be used to monitor voltage and current levels supplying each of the sensors 16.

External control of the Secure-Net Unit 2 is available to a user of the unit via a client control unit 17 which allows the user to activate or deactivate the security monitoring sensors via its connection with the security system monitoring module 15.

It is not, however, possible for a user of the unit to deactivate the tracking and monitoring systems which may only be deactivated by the secure-net monitoring system operator. As well as changes in state being monitored by the security system monitoring module 15 (for example from on to off or open to closed) the security system monitoring module may be programmed to quantitatively monitor certain inputs to provide an output value indicative of the level of the input. The security system monitoring module 15 outputs information derived from external sensors 16 and client control unit 17 to the cellular communication module 11 for transmission via aerial 3 to the secure-net monitoring computer system 8.

An action response control module 18 receives instructions from the security system monitoring module 15 along with instructions from the secure-net monitoring computer system 8 via the cellular network and aerial 3 through the cellular communication module 11. In response to instructions, the action response control module 18 outputs control signals to selected electrically powered equipment or circuits 19 within the vehicle 1. The selected equipment or circuits may include ignition disable control, electric window control and door lock control. The action response control module 18 also has the ability to undertake a range of pre-programmed automatic responses determined by the status of the sensors and the security system monitoring module 15. The status of the external electrical circuits or devices 19 are also relayed back to the secure-net monitoring station 8.

Ordinarily power is supplied to the Secure-Net Unit 2 by the vehicle power supply, for example, battery 20. In the event of disconnection of the vehicle power supply 20, the Secure-Net Unit is provided with its own back-up power supply in the form of rechargeable battery 21.

The secure-net monitoring computer system 8 is, for example, based around an 80486 66 MHz personal computer connected to the cellular network by channel 9. The secure-net monitoring computer system 8 contains software which includes the capability of tracking and mapping vehicle 1, a table containing action requirements corresponding to various alarm conditions, customers' equipment details (referenced by their unique identification code as previously described) and the computer system may also incorporate customer details for billing purposes.

In use, the vehicle or piece of equipment 1 may be fitted with an anti-theft security system such that if the vehicle is tampered with or stolen a silent alarm is triggered. The activation of the silent alarm (which may be a components of circuits 19) is monitored by the security system monitoring module 15 which notifies the cellular communication module 11 of the status of the alarm. Cellular communication module 11 then transmits a signal via aerial 3 and the cellular telephone network to the secure-net monitoring computer system 8. The transmitted signal received by the secure-net computer system contains the unique identification number, data corresponding to the Secure-Net Units location and the status of the security sensors and control outputs of the Secure-Net Unit

2. An audible alarm may also be activated at the secure-net monitoring system's computer if required.

The secure-net monitoring and control computer system 8 receives the transmitted information from the Secure-Net Unit 2 which is then processed. Software within the secure-net monitoring and control computer determines the position of the vehicle 1 by comparing the signal strength and cell site identification information with a table of actual positions for each of the cell sites using geometric calculations. The position of the vehicle 1 may then be displayed on an operator's screen superimposed, for example, upon a map of the relevant area which the vehicle is in. Also revealed on an operator's screen is the client contact details and the details of the vehicle (for example registration number, colour or an electronically scanned image of the equipment, vehicle or person). Special instructions which have been stored with reference to the vehicle are then displayed to instruct the operator what actions the client requires to be taken. The secure-net monitoring computer system 8 then annotates the client billing and produces a hard copy of the alarm received and action taken. This information may also be fed to the police computer system and displayed on the operation room screen at the police department if required.

At this point, the secure-net monitoring and control computer station has the ability to initiate predetermined control actions. For example, the vehicle may be wired and programmed so that, upon the secure-net monitoring and control computer 8 initiating a command to the cellular communication module 11 within the Secure-Net Unit 2, car windows may be wound up, doors locked or ignition disabled as required or instructed by the client. These functions are performed as has previously been described by the action response control module enabling certain outputs to electrically powered equipment or circuits 19 within the vehicle 1.

The security system monitoring module 15 may also be connected to continuously monitor battery 20 or battery 21, ambient light conditions (by connection to a photometer), temperature for example the temperature of a refrigerated unit within the vehicle or ambient temperature, tilt switches, passive infrared sensors, sound detectors and location (by for example connection to a Global Positioning Satellite (GPS) system). It should, however, be noted that each of these sensors could alternatively be connected as

external digital devices 14 via the data input/output module 13 or through a connection to the vehicle movement and direction sensing module 23.

Under normal non-alarm operating conditions the cellular communication module 11 of the Secure-Net Unit 2 will be programmed to make one call per day to the secure-net monitoring computer system 8 in order to confirm the current position of the vehicle 1. In this way, charges for cellular telephone calls will be minimised. Under alarm conditions, calls will be made at the discretion of the secure-net monitoring computer 8 and the cellular communication module 11. The vehicle movement and direction sensing module 23 will supply and update estimated position information based on inputs from the inclinometer, compass and trip counter.

It should be noted that rather than the position location discriminator simply receiving and then forwarding the positional information to the monitoring computer which then determines the vehicles position, the occasionally received signal strength and identification information from the receivable cellular transmitters could be used by the position location discriminator (which could be sent or could permanently hold the physical location information relating to each transmitter) to calculate the vehicles static position which could then be transmitted to the monitoring computer along with information from the VMDSM. Alternatively, the position location discriminator could combine the calculated static position with the information relating to the movement and orientation sensed by the VMDSM and transmit a more accurate position to the monitoring computer. It should also be noted that all of the functions of the Secure-Net Unit can be remotely programmed from the monitoring computer system so that the actions taken and output transmitted by the SNU in response to various situations can be altered depending on the requirements of the specific vehicle.

The cellular communication module 11 continuously receives cellular control signals transmitted by all receivable cellular network transmitters. The signal strength and identification of the cellular network transmitter is stored in memory and updated regularly at:

i) predetermined times,

ii) alarm conditions, or

iii) the request of the monitoring station

A further possible application of the SNU is in the field of automated medical monitoring in which a patient has his or her vital signs such as heart rate, blood pressure and sugar levels monitored by the SNU and transmitted to a monitoring computer. The monitoring computer may decide upon actions to take in association with skilled medical practitioners if various situations were to arise . The monitoring computer may then issue control signals over the digital cellular telephone system to the SNU which may then dispense medication, for example, through a syringe to the patient. In cases where the patient is capable of movement the Secure-Net Unit can also transmit positional information to the monitoring computer so that the location of the patient may be remotely monitored. This aspect of the invention would also be beneficial for remote monitoring of prisoners who, for example, are permitted strictly monitored but limited freedom away from prison.

It should also be noted that equipment or circuits 19 within the Secure-Net Unit 2 may encompass entire industrial processes, for example pumps, motors or other electro/mechanical systems, which could then each be remotely controlled allowing full remote industrial control and monitoring.

The present invention, by not only monitoring the position of a vehicle and status of alarms within the vehicle, has the added benefit of allowing control of various vehicle systems remotely. The system also allows any standard commercial digital device to be connected to the Secure-Net Unit allowing normal communication over the cellular telephone network for voice, fax or computer transmissions. It is anticipated that these improvements over the prior art will be perceived as extremely advantageous as the present invention provides a deterrent to crime as well as making the vehicle a mobile general purpose digital communication centre.

CLAIMS:

1. Interactive equipment monitoring apparatus wherein said equipment is located within a cellular communication network having fixed cellular network transmitters which, depending on their spatial relationship with said equipment are either able to be received (receivable) or not receivable comprising:

first transceiving antenna means located on said equipment,

first control means which receives signals from said fixed receivable cellular network transmitters via said first transceiving antenna means, said signals including signal strength and unique identification information for all said receivable cellular network transmitters, said first control means also being provided with inputs from sensors monitoring the status of selected functions of said equipment and having outputs to control selected equipment systems and an output to said first transceiving means to allow transmission of information received from said sensors monitoring said selected equipment systems and status information of said functions, said first control means being able to alter the status of said equipment systems,

second transceiving means remotely located from said equipment which transmits and receives information to and from said first transceiving means, and

second control means, remotely located from said equipment, connected to said second transceiving means which receives said information from said first control means and which also transmits control signals to said first control means in response to said information received to control the status of said selected equipment systems to allow remote control and monitoring of said selected equipment systems.

2. Interactive equipment monitoring apparatus as claimed in claim 1 wherein one of said functions monitored by said sensors is distance travelled and direction of travel and said first control means transmits to said second control means information derived from said signal strength and identification information from said receivable cellular network transmitters as well as said information relating to the distances and directions of travel of said equipment and said second control means is also provided with information on the

physical location of said fixed cellular network transmitters and is thereby able to continuously determine the position of said equipment.

3. Interactive equipment monitoring apparatus as claimed in claim 1 wherein said first control means processes said information received from said sensors monitoring said selected equipment activities and transmits this processed information to said second control means which, in response to said information, transmits commands to said first control means to output appropriate control signals to control the status of said selected equipment systems.

4. Interactive equipment monitoring apparatus as claimed in claim 1 or claim 2 wherein said first control means transmits information to said second control means at a predetermined time.

5. Interactive equipment monitoring apparatus as claimed in claim 1 or claim 2 wherein said first control means transmits information to said second control means at the request of said second control means.

6. Interactive equipment monitoring apparatus as claimed in claim 1 or claim 2 wherein said equipment is a vehicle and said selected monitored functions include the status of alarms within said vehicle which determine whether the vehicle has been entered or started.

7. Interactive equipment monitoring apparatus as claimed in claim 1 or claim 2 wherein said equipment is a vehicle and said selected systems controlled by said first control means include ignition disable control, door lock control, electric window control and headlight control.

8. Interactive equipment monitoring apparatus as claimed in claim 6 wherein said selected monitored functions also include the monitoring of ambient light and temperature at positions within said vehicle.

9. Interactive equipment monitoring apparatus as substantially as herein described with reference to and as illustrated by the accompanying drawings.

10. A method of tracking the location and movement of equipment located within a cellular communication network having fixed cellular network transmitters which, depending on their spatial relationship with said equipment are either able to be received (receivable) or not receivable wherein said equipment is provided with sensing means to constantly determine information relating to the movement and orientation of said equipment from distance measuring means, turn angle measuring means and compass means and said equipment is also provided with static position determining means to determine information relating to the approximate position of said equipment, said method comprising the steps of:

i) receiving and storing information from said sensing means in a first in first out memory substantially continuously such that the most recently received information replaces earlier received information,

ii) occasionally receiving information from said static position determining means,

iii) combining said information received from said static position determining means with said stored information from said sensing means to substantially continuously determine the position of said equipment.

11. A method of tracking the location and movement of equipment as claimed in claim 10 wherein said step of occasionally receiving said information from said static position determining means occurs at a predetermined time.

12. A method of tracking the location and movement of equipment as claimed in claim 10 wherein said equipment includes an alarm monitoring the status of said equipment and said step of occasionally receiving said information from said static position determining means occurs in response to said alarm being raised.

13. A method of tracking the location and movement of equipment as claimed in claim 10 wherein said information from said sensing means and said static position determining

means are each transmitted to a control means which substantially continuously determines the position of said equipment and said step of occasionally receiving said information from said static position determining means occurs at the request of said control means.

14. A method of tracking the location and movement of equipment as claimed in claim 10 wherein said step of occasionally receiving information from said static position determining means comprises monitoring the signal strengths of all receivable cellular telephone transmitters, said cellular transmitters having known positions and transmitting identification information so that, the position of said equipment in relation to said receivable cellular transmitters can be determined.

15. A method of tracking the location and movement of equipment as herein described with reference to and as illustrated by the accompanying drawings.

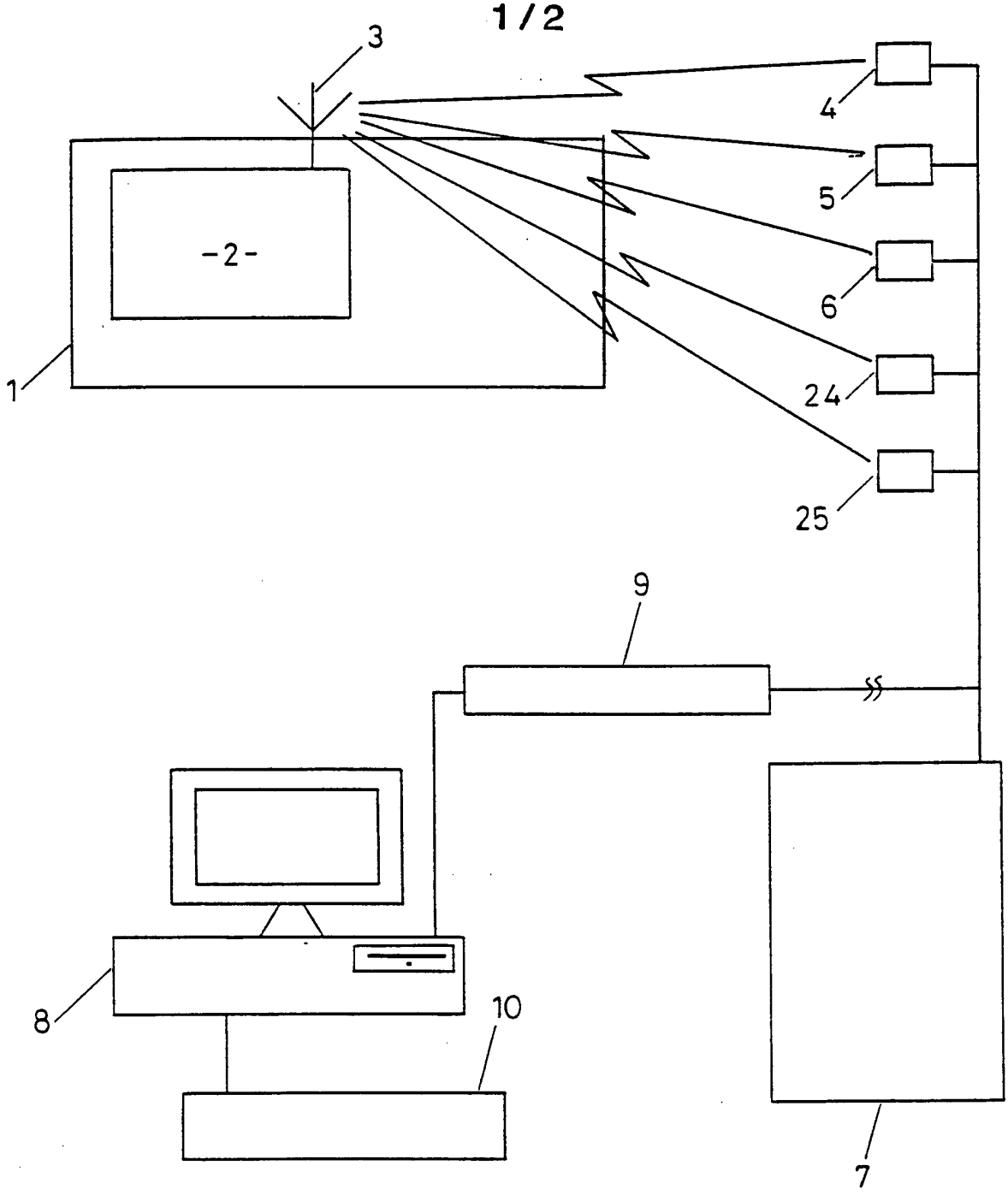

FIG 1

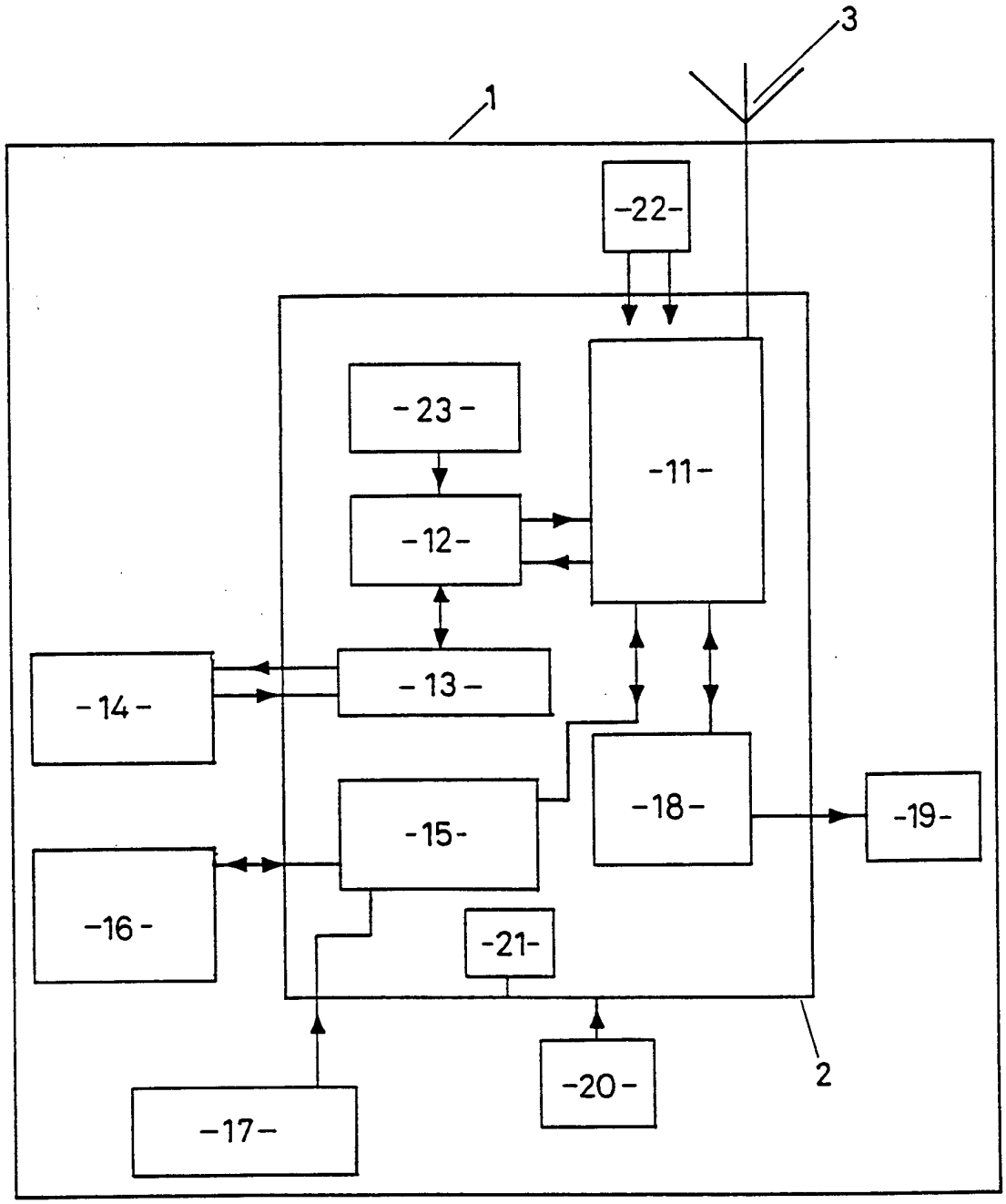

FIG 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ 95/00014

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl.[6] G08B 25/10, G08G 1/127

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC G08B 25/00, 25/10, G08G 1/12, 1/127

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU:IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)
Derwent: cellular
Japio: cellular

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X Y	EP 505266 A1 (Telediffusion de France) 23 September 1992. Abstract column 11, lines 35-44.	1 2-15
Y	EP 501058 A2 (By-Word Technologies Inc) 2 September 1992 Whole document	1-15
Y	EP 350554 A2 (Automated Security (Holdings) Plc) 17 January 1990 Whole document	1-15

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
12 April 1995 (12.04.95)	5 JUNE 1995 (05.06.95)
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	Authorized officer **R.Tolhurst** Telephone No. (06) 2832187

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ 95/00014

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
Y	WO 94/15412 A1 (Stanford Teleecommunications Inc) 7 July 1994 Whole document	1-15
Y	WO 89/12835 A1 (Brown) 28 December 1989 Whole document	1-15
Y	US 5218367 A (Sheffer) 8 June 1993 Whole document	1-15
Y	GB 2191365 A (Mitchell) 9 December 1987 Whole document	1-15
Y	GB 2218835 A (Trackmobile Inc) 22 November 1989 Whole document	1-15
Y	GB 2247761 A (Davies) 11 March 1992 Whole document	1-15
Y	EP 242099 A2 (Advanced Strategics Inc) 21 October 1987 Whole document	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family membe.

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This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member		
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END OF ANNEX